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This report presents an analysis of motorcycle usage data available from the 1974 Gallup Motorcycle Survey. In addition to simply presenting these data, an attempt is made to compare motorcycle usage with the Federal Test Procedure being proposed in the NPRM for testing motorcycles. It is recognized that insufficient survey data exist to fully quantify how motorcycles are used; the attempt in this report is to study the available data, qualitatively compare the data to the driving cycles, and recommend areas in which additional data would be useful. Data obtained in this study include average trip length, frequency, and speed plus areas commuted through.

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Abstract

The 1974 Gallup Motorcycle Survey is analyzed to obtain average urban usage data. Data obtained include average trip length, frequency, and speed plus areas commuted through. A qualitative comparison to the HPDM Motorcycle Driving Cycles is made. Areas where additional data would be useful are identified.

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Introduction

This report presents an analysis of motorcycle usage data available from the 1974 Gallup Motorcycle Survey. In addition to simply presenting these data, an attempt is made to compare motorcycle usage with the Federal Test Procedure (FTP) driving cycle being proposed in the NPRM for testing motorcycles. It is recognized that insufficient survey data exist to fully quantify how motorcycles are used; the attempt in this report is to study the available data, qualitatively compare the data to the driving cycles, and recommend areas in which additional data would be useful.

Summary

- The average urban trip length for street legal motorcycles is 3.2 miles.
- The average trip frequency is 3.2 trips per day. (Motorcycle use is seasonal; these data are representative of use in the month of May.)
- The calculated average commuting trip speed is 29 miles per hour.
- Small displacement motorcycles are used less frequently and over shorter distances at lower speeds.
- Over one half the large displacement motorcycles but slightly less than 20 percent of the small displacement motorcycles use the freeways for commuting.
- It is recommended that the light duty vehicle weighting factors be used for calculating emissions from uncontrolled and 1978 level controlled motorcycles. The effect of weighting factors on calculated emissions will become more important as emissions from motorcycles are controlled, and the determination of more accurate weighting factors specific to motorcycles would be recommended.
- The usage data obtained from the Gallup Survey is insufficient to determine if a different driving cycle for motorcycles is needed. Because the usage data indicate higher average speeds and shorter trip lengths for motorcycles, obtaining more detailed usage data to further quantify driving characteristics is recommended.

Discussion

A subset of the Gallup National Motorcycle Survey data was used for this analysis. The subset contained data which were the intersection of the following categories of responses and classifications:

Street and Dual Purpose Motorcycles
Engine Displacement ≥ 50 cc
Registered
Working Odometer
Reside in a city with population of ≥ 50,000

This subset is representative of street legal motorcycles whose owners reside within cities with populations greater than or equal to 50,000. This data set was chosen so that the data would be as representative of urban motorcycle usage as possible.

The specific Gallup survey questions upon which the following data are based are presented in the Appendix.

Average Trip Length

Tables I and II present a summary of trip characteristics for commuting and non-commuting trips. The overall average trip length is calculated by weighting the trip lengths by both the frequency of trips and by the percent of the population which is making the specific type of trip. The latter weighting is required because motorcycles are not used for all types of trips (only 59 percent of owners use motorcycles to commute, for example).

The average trip length, based on the data in Table I and II is calculated to be:

	Average urban trip length
CC ≤ 50	3.2 miles
CC ≥ 170	3.4 miles
50 ≤ CC < 170	4.0 miles

The trip length shown above is representative of urban use. For the average trip length for "non-commuting trips greater than 10 miles one way", (a survey question, see the Appendix), it was assumed the first 10 miles of each trip was urban and therefore 10 miles was used for that trip length. No actual average length for trips greater than [illegible] survey question but [illegible] trip frequency was used.

Frequency of Trips

[illegible] frequently seasonal or may be of a recreational nature only. Thus the average number of trips per day, as determined from the survey data, will vary depending on whether those data indicating zero trips of a specific type are included in the average. For example, 49 percent of the owners surveyed did not take any 2 to 10 mile non-commuting trips in the last week. Because respondents were asked questions about usage in the month just prior to the survey, these data are representative of use in the month of May. The results may be different for other seasonal periods.

The average frequency of all types of trips combined, which includes in the calculation those owners not using their motorcycles for a specific type of trip in the last week, (i.e., zero trip response), was calculated by summing the number of trips for each category for each survey response. The average number of trips per day (zero trip motorcycles included) is:

Average Trip Frequency in May

CC ≥ 50	3.1 trips/day
CC ≥ 170	3.6 trips/day
50 ≤ CC < 170	1.7 trips/day

Weekly Mileage

As a check on the validity of the average trip frequency and length, the calculated weekly mileage is compared to the estimated weekly mileage (a survey question, see the Appendix). The estimated average weekly mileage includes inactive motorcycles.

Comparison of Weekly Mileage, Miles

	Calculated[1]	Estimate[2] Total Weekly Mileage	Estimate[2][3] On Road Weekly Mileage
CC ≥ 50	113	109	93
CC ≥ 170	136	125	115
50 ≤ CC < 170	48	45	33

(1) Miles per trip times trips per day times 7 days per week.
(2) A Survey Question
(3) Off road riding not included

The weekly mileage calculated from the average trip lengths and frequencies compare closely with the survey's estimated total weekly mileage. The calculated mileage is higher than the estimate of weekly

from estimates the difference is [illegible] and supports the original values of trip and length frequency.

Average Speed

The survey asked how long it took to travel to work or school. Using these data plus the average commuting trip length, an average speed was calculated. The average speed for commuting trips is:

Calculated Average Commuting Trip Speed

CC ≥ 50	29.2 mph
CC ≥ 170	30.2 mph
50 ≤ CC < 170	22.7 mph

The large displacement motorcycles show a higher average speed, probably due to traveling part of the trip at highway speeds (see next section). Breaking the commuting trips into school and work trip speeds, the large displacement work trip is the only type of commuting trip with a significantly higher average speed.

	Calculated Average Commuting Trip Speed	
	To Work	To School
CC ≥ 170	33.8 mph	23.1 mph
50 ≤ CC < 170	22.8 mph	22.4 mph

No data on non-commuting trip speeds are available from the survey.

Areas Commuted Through

Commuters were asked what areas they commute through. The results are presented in Table III. The data show about one half commute through downtown and industrial areas, and about 80 percent commute through suburban and residential areas. There is little difference among the two engine displacement classes. Approximately 20 percent commute through rural areas. Only three percent commute solely in rural areas, which is a result of analyzing only the responses from city dwellers.

Fifty-five percent of the large displacement owners commute on the freeways, while only 19 percent of the small motorcycles are used on the freeways for commuting. The latter figure reflects the fact that in many states the smaller displacement motorcycles are legally prohibited from using the freeways.

Hot/Cold Weighting Factors

The data needed to determine the hot/cold start weighting factors, which are used in the total emissions calculations, are not available from the Gallup Survey. In the NPRM, the light duty vehicle value of 0.43 cold starts per start is used.

The importance of accurately knowing the weighting factors depends on the ratio of cold transient to hot transient emissions. For simplicity, [illegible] has been eliminated, the total weighted emissions can be expressed as:

$$V_{we} = \frac{n_c}{n_c + n_h} V_{et} + \frac{n_h}{n_c + n_h} V_{ht} + V_s \qquad (1)$$

where

V_{we} = Total weighted mass emissions of a given pollutant.

V_{et} = Mass emissions from the cold transient portion of the driving cycle.

V_{ht} = Mass emissions from the hot transient portion of the driving cycle.

V_s = Mass emissions from the stabilized portion of the driving cycle.

n_t = Total number of starts per day.

n_c = Number of cold starts per day.

n_h = Number of hot starts per day.

Substituting $1 - n_c/n_t$ for n_h/n_t and taking the derivative of V_{wm} with respect to n_c/n_t gives:

$$\frac{d\,V_{wm}}{d(n_c/n_t)} = V_{ct} - V_{ht}$$

The change in total weighted emissions due to a change in the weighting factor n_c/n_t is equal to the difference between cold and hot transient emissions. If the hot and cold transient emissions are equal, then the weighting factors have no effect on the calculated weighted emissions.

A review of emission data collected at EPA using the NPRM test procedure shows that the ratio of cold to hot start emissions is approximately one for most motorcycles tested. Quantitatively, 85 percent of the ratios are in the range of 0.8 to 1.2. Within this range, a change in cold weighting factor of .3 (from .43 to .73, for example) results in less than a five percent change in calculated weighted emissions.

The level of transient emissions for uncontrolled motorcycles tends to mask any differences in cold and hot transient emissions. Since the proposed 1978 level of control results in only moderate decreases in emissions for most motorcycles, the ratio of cold to hot transient emissions will most likely remain at approximately one. Thus it is recommended that the light duty vehicle weighting factors be used for calculating emissions from uncontrolled and 1978 level controlled motorcycles. As motorcycles are controlled more stringently, the differences in cold and hot transient emissions may become significant, and the determination of weighting factors specific to motorcycles may be needed.

Comparison with the FTP Driving Cycle

The results presented in the previous sections are based on survey data, and their accuracy depends on the respondents ability to estimate frequencies, distances, and times. In addition, the data are not complete; for example the average trip velocity can be indirectly calculated only for commuting trips. With these qualifications in mind, a comparison of the Gallup survey results to the FTP for each engine displacement category is presented below. The motorcycle FTP driving cycle speed versus time

for the large displacement motorcycles is identical to the light duty vehicle driving cycle. The high speed portion of the transient test (bags 1 and 3) has been scaled down by the factor 0.64 for the small displacement motorcycles.

	50 ≤ CC < 170		CC ≥ 170	
Parameter	Gallup	FTP	Gallup	FTP
Urban trip length, miles	4.6	6.8	5.4	7.5
Trip average speed, mph	22.7(1)	17.8	30.2(1)	19.7

(1) Commuting trips only.

The trip lengths obtained from the survey are shorter than represented by the test procedure, and the average commuting speeds are higher. The average speed would probably be reduced, especially for the large motorcycles, if data on non-commuting trips were available and were included. The argument that motorcycles are constrained by traffic to the same average speeds as light duty vehicles is still strong. The reduction of the maximum test speed for small displacement motorcycles appears justified based on their lower trip speed and the small percentage of reported freeway usage (Table III).

The Gallup data presented here is not sufficient to decide if a different driving cycle for motorcycles is needed. It does suggest, however, that trip length for motorcycles may be less than LDVs. The average speed, being based only on commuting trips and an indirect computation is insufficient to claim motorcycles in general travel at higher average speeds than LDVs. The importance of this parameter on emissions suggests that obtaining further data on average speed should be pursued.

Table I

Gallup Usage Data - Commuters

(Street Legal Motorcycles in Cities)

er (1)	Question Number	50 ≤ CC <170	CC ≥ 170	CC ≤ 50
to work only				
rcent that commute to work	16	26	51	4
les to work, 1 way	17	5.6	10.2	9.6
Trips in last 20 work days (2)	19b	16.7	13.8	14.0
to school only				
rcent that commute to school	16	4	3	3
les to school, 1 way	20	5.8	6.4	6.2
Trips in last 20 school days (2)	22b	21.1	19.5	20.0
to school and work				
rcent that commute to both	16	9	12	11
les to work, 1 way	17	5.9	8.7	8.2
Trips in last 20 work days (2)	19b	17.4	13.7	14.4
les to school, 1 way	20	2.6	7.0	6.3
Trips in last 20 school days (2)	22b	10.4	12.9	12.5
ted data				
erage speed to work, mph	-	23	33	32
erage speed to school, mph	-	22	23	23
muters				
rcent that commute	16	39	66	59
mmuting trip miles, 1 way	-	5.3	9.4	8.7
Trips in last 20 work / school days (2)	-	16	14	14

(1) values are averages.

erage of those who took trips; zero trips not included.

Table II

Gallup Usage Data - Non-Commuting Trips

(Street Legal Motorcycles in Cities)

Parameter	Question Number	50 ≤ CC ≤170	CC > 170	CC ≥ 50
In last 7 days (1)				
# of trips < 2 miles 1 way	26	6.6	8.2	7.9
# of trips 2-10 miles 1 way	27	5.9	6.5	6.4
# of trips > 10 miles 1 way	28	7.2	4.1	3.9
(1) Average of those making non-commuting trips; zero trips not included.				
Not making at least 1 trip in last 7 days				
# of trips < 2 miles 1 way	26	42	56	53
# of trips 2-10 miles 1 way	27	30	52	51
# of trips > 10 miles 1 way	28	20	47	44

Table III

Gallup Usage Data - Areas Commuted Through

(Street Legal Motorcycles in Cities)

Parameter	Question Number	50 ≤ CC ≤ 170	CC > 170	CC ≤ 50
...nt of sample that commute	15	39	66	59
...nt of Commuters that commute through:	24			
Downtown, industrial areas		49	48	48
Suburban, residential areas		78	80	80
Rural areas		15	21	22
Rural areas only		0	3	3
...nt that commute on freeways	23	19	55	49

Appendix

Questions from Gallup Survey

ASK ALL OWNERS:

15. Approximately what percentage of the miles on this cycle do you think were for street riding?

    %_____ %_____ %_____

16. In which of the following ways do you use this motorcycle on the street? (read list) Do you . . .

Commute to work?	1[ ]	1[ ]	1[ ]
Commute to school?	2[ ]	2[ ]	2[ ]
Ride for other purposes?	3[ ]	3[ ]	3[ ]
None	0[ ]	0[ ]	0[ ]
Other (specify)	x[ ]_____	x[ ]_____	x[ ]_____

MOST RECENT 2nd 3rd

IF USED TO "COMMUTE TO WORK" IN Q. 16, ASK QUESTIONS 17 - 19b:

17. How many miles one way is this trip?

    Miles_____ Miles_____ Miles_____

18. How long does it take one way?

    _____Hours _____Minutes _____Hours _____Minutes _____Hours _____Minutes

19a. If the weather is good do you ride your motorcycle to work on a regular basis?

Yes	1[ ]	1[ ]	1[ ]
No	2[ ]	2[ ]	2[ ]

19b. How many round trips to work did you make during the past twenty working days?

    Number_____ Number_____ Number_____

IF USED TO "COMMUTE TO SCHOOL" IN Q. 16, ASK QUESTIONS 20 - 22b:

20. How many miles one way is this trip?

    Miles_____ Miles_____ Miles_____

21. How long does it take one way?

    _____Hours _____Minutes _____Hours _____Minutes _____Hours _____Minutes

22a. If the weather is good do you ride your motorcycle to school on a regular basis?

Yes	1[ ]	1[ ]	1[ ]
No	2[ ]	2[ ]	2[ ]

22b. How many round trips to school did you make during the past twenty school days?

    Number_____ Number_____ Number_____

Appendix - Cont.

ASK ALL COMMUTERS EITHER TO WORK OR SCHOOL QUESTIONS 23 & 24:

23. Do you commute either on freeways, expressways, or turnpikes with this cycle?

Yes	1[ ]	1[ ]	1[ ]
No	2[ ]	2[ ]	2[ ]

24. Which of these areas do you commute through:

Downtown business or industrial areas?	1[ ]	1[ ]	1[ ]
Suburban or residential areas?	2[ ]	2[ ]	2[ ]
Rural areas?	3[ ]	3[ ]	3[ ]

ASK ALL OWNERS:

26. Other than for commuting . . . in the past seven days how many trips did you make that were within two miles from your home?

# of Trips_____ # of Trips_____ # of Trips_____

27. Other than for commuting . . . in the past seven days how many trips did you make that were within two to ten miles from your home?

# of Trips_____ # of Trips_____ # of Trips_____

28. Other than for commuting . . . in the past seven days how many trips did you make that were over ten miles from your home?

# of Trips_____ # of Trips_____ # of Trips_____

29. Considering now your motorcycle usage for all purposes to include commuting and other purposes . . .

Thinking now about your average weekly usage during the past four weeks, how many miles did you ride in an average week?

Miles_____ Miles_____ Miles_____